DTE Energy®

Detroit Edison's Advanced Implementation of Community Energy Storage Systems for Grid Support (DE-OE0000229)

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Agenda

- CES Overview
- Project Team & Roles
- Project Phases and Schedule
- CES Operating Zones
- Communication & Control Architecture
- CES Modes of Operation
- CES Baseline & Location Selection Criteria
- CES Test Plan
- Secondary Use of Electric Vehicle Batteries
- Future Work

Community Energy Storage

- The project is a proof of concept of an aggregated Community Energy Storage (CES) system in a utility territory; demonstrating the following capabilities:
  - Voltage/VAR Support
  - Integration renewable generation
  - Islanding during outages
  - Frequency Regulation
- Demonstrate the application of secondary-use EV batteries as CES devices. Identifying alternative applications for EV type batteries may accelerate the reduction of cost for electric vehicle batteries.
- Identify gaps, areas of improvement, and provide suggestions on how CES devices and control algorithms can be standardized to be used across the U.S.
- Provide a functional and economic analysis for using the CES system in electric utility applications.

Project Team and Role

Project Team Members & Roles	
Team Member	**Role**
DTE Energy	• Project lead • Utility participant for CES filed demo • Project reporting
S&C A123 SYSTEMS	• CES Unit suppliers • Factory acceptance testing • Technical Support
KEMA	• CES functional testing • Economic analysis and reporting • Technical Support
edd	• Circuit model development for baseline • Reliability & economic dispatch algorithm
CHRYSLER	• Durability & conditioning testing of EV battery • Secondary use EV battery supplier • Provide baseline data for EV battery
NEXTENERGY	• Investigation of regulatory issues surrounding energy storage and renewables
nationalgrid	• Technical Support

Project Phases

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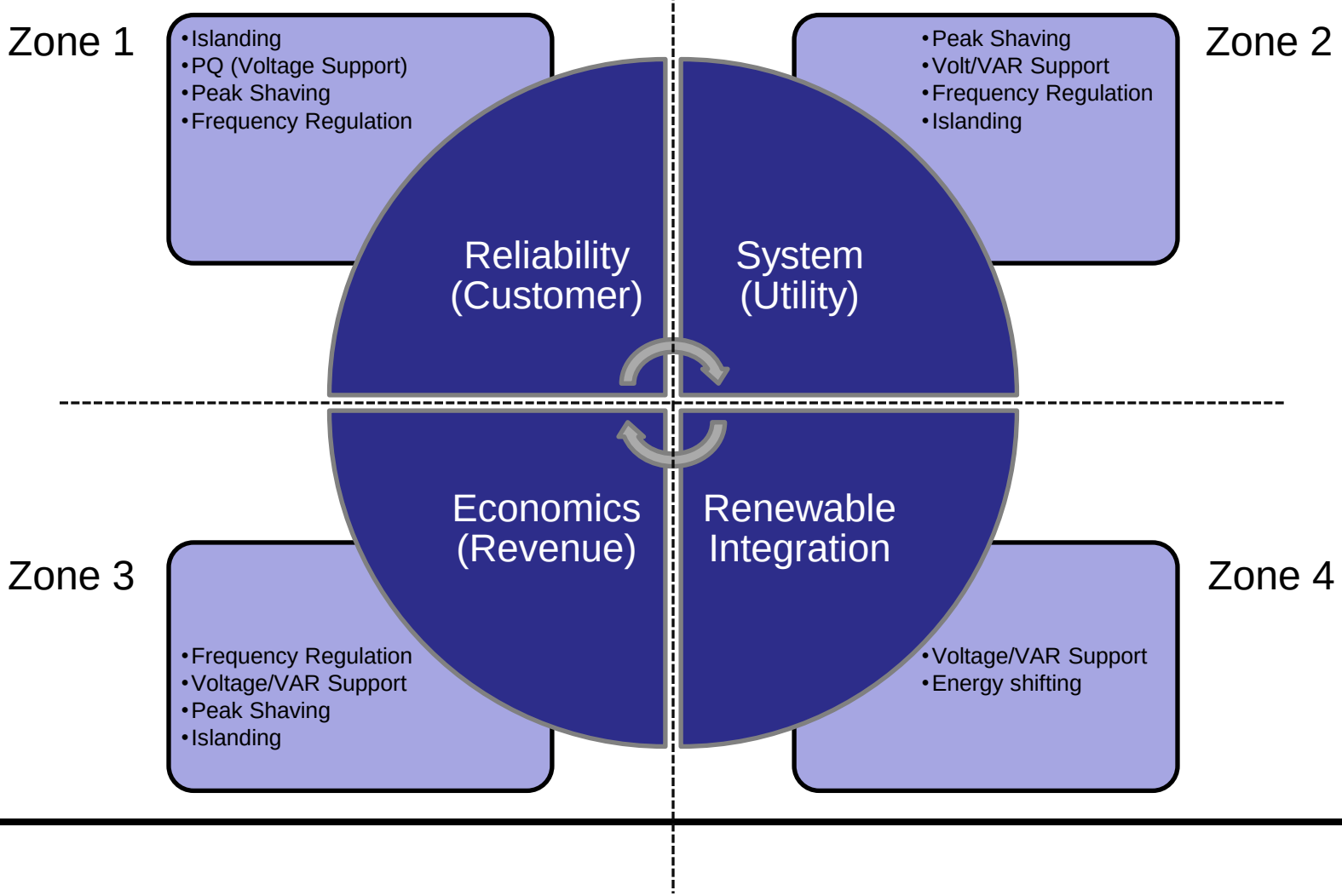
Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Project Definition and NEPA Compliance	**Final Design and Construction**	**Commissioning and Operations**	**Utilization of Secondary Use Batteries**	**Write Up of Demonstration Assessment**
• Update Project Management Plan • NEPA Compliance • Baseline for Evaluating Project Performance • Preliminary Design & Planning	• Finalize Design of CES System • CES System Design for Project • Planning, Measuring, Architecture and Algorithms • Creation of Dispatch Algorithms •Communications and Control •Procurement of CES Systems for Installation	• Commissioning of Operational Functionalities • Field Testing of Designed CES Capabilities • Data Monitoring and Collection of Performance Data • Reporting of Data and Operation	• Integration of Secondary Use Batteries	• Write final report
01/2010-05/2011	**01/2011-06/2012**	**07/2012-12/2014**	**07/2013-06/2014**	**07/2014-12/2014**

CES – Operating Zones



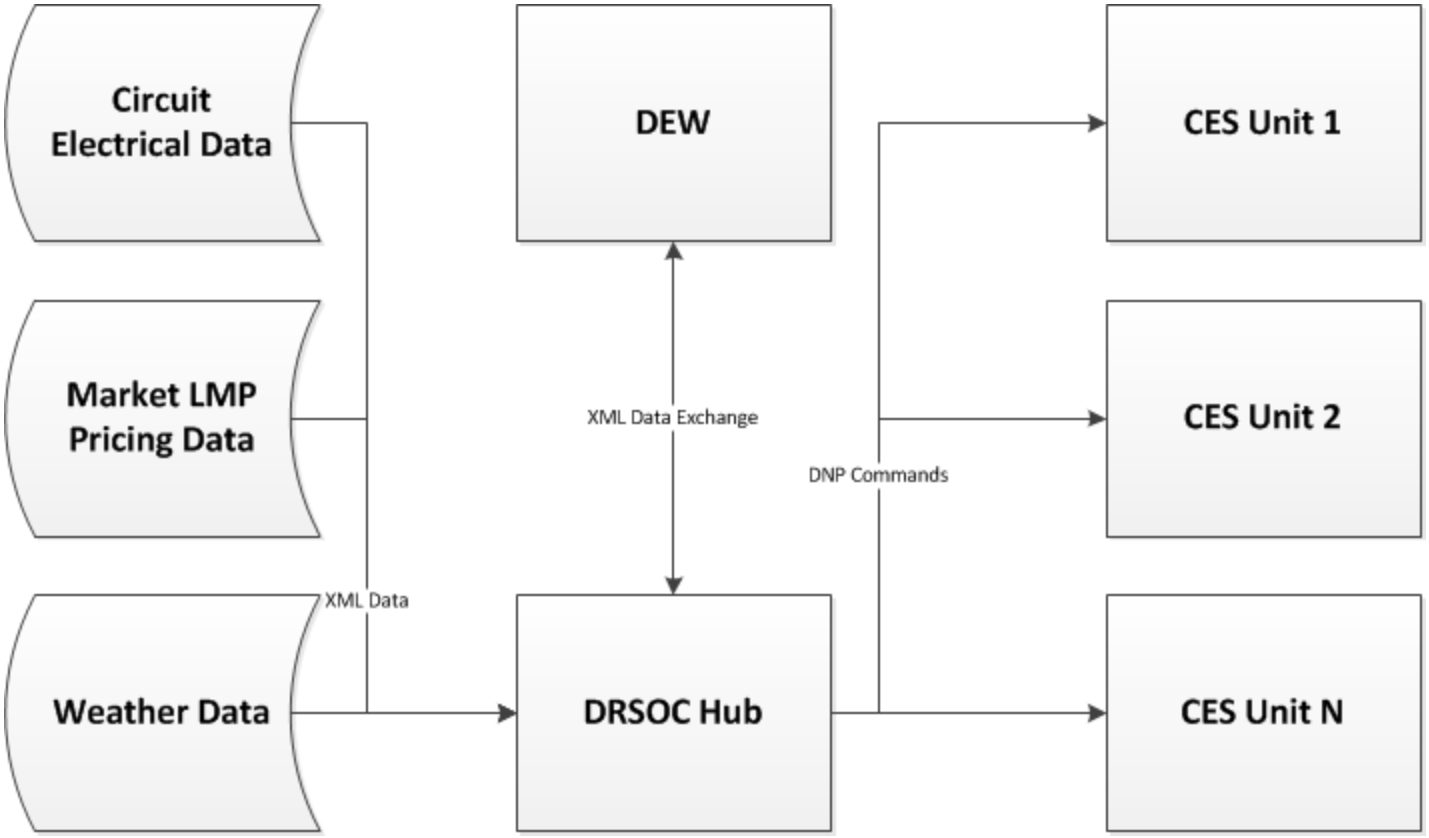
Modes of Operation

- Standby Operation Mode
  - Locally-initiated operation due to power loss or site-specific power quality issue.
  - This mode of operation pre-empts all other modes unless specifically overridden.
- Scheduled Operation Mode
  - Control is initiated by the DRSOC Hub on a pre-defined unit-specific schedule.
- Automatic Generation Control (AGC) Mode
  - Aggregate kW output is requested by the Independent System Operator (ISO). Individual units are dispatched by the DRSOC Hub at the appropriate outputs to meet the AGC set-point.
- Hub Command Mode
  - Control is initiated by an operator and dispatched on a unit-specific basis by the DRSOC Hub.
- Peak-shaving Mode
  - Units are dispatched by the DRSOC Hub to ensure that circuit ratings are not exceeded.

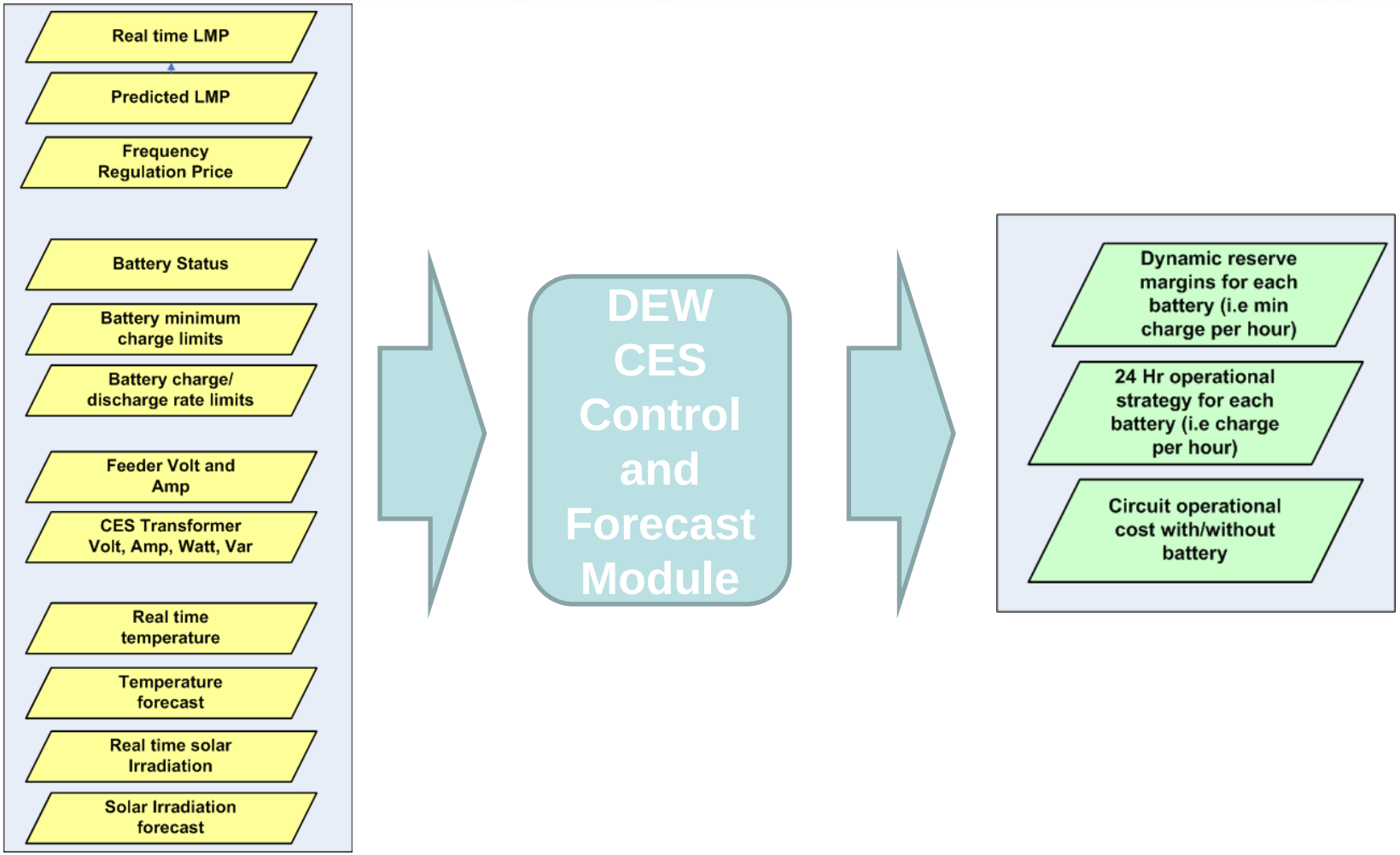
Modes of Operation (Continued)

- DEW Economic & Reliability Dispatch Modes
  - Control is initiated by algorithms implemented in the DEW software package.
  - Algorithms are intended to maximize the economic potential of the unit.
  - May include running of the CES units in grid-parallel mode under normal circuit conditions.
  - Dispatching is done by the DRSOC Hub to each CES unit.
- DEW Model-Based Real Time Control
  - CES Operation Modes:
    - Normal: Economic
    - Storm: Reliability (Load Serving)
  - Objective Function:
    - Minimize Operation Cost
    - Minimize Loss
    - Maximize Load Serving Time After Outage

CES - Communications Architecture



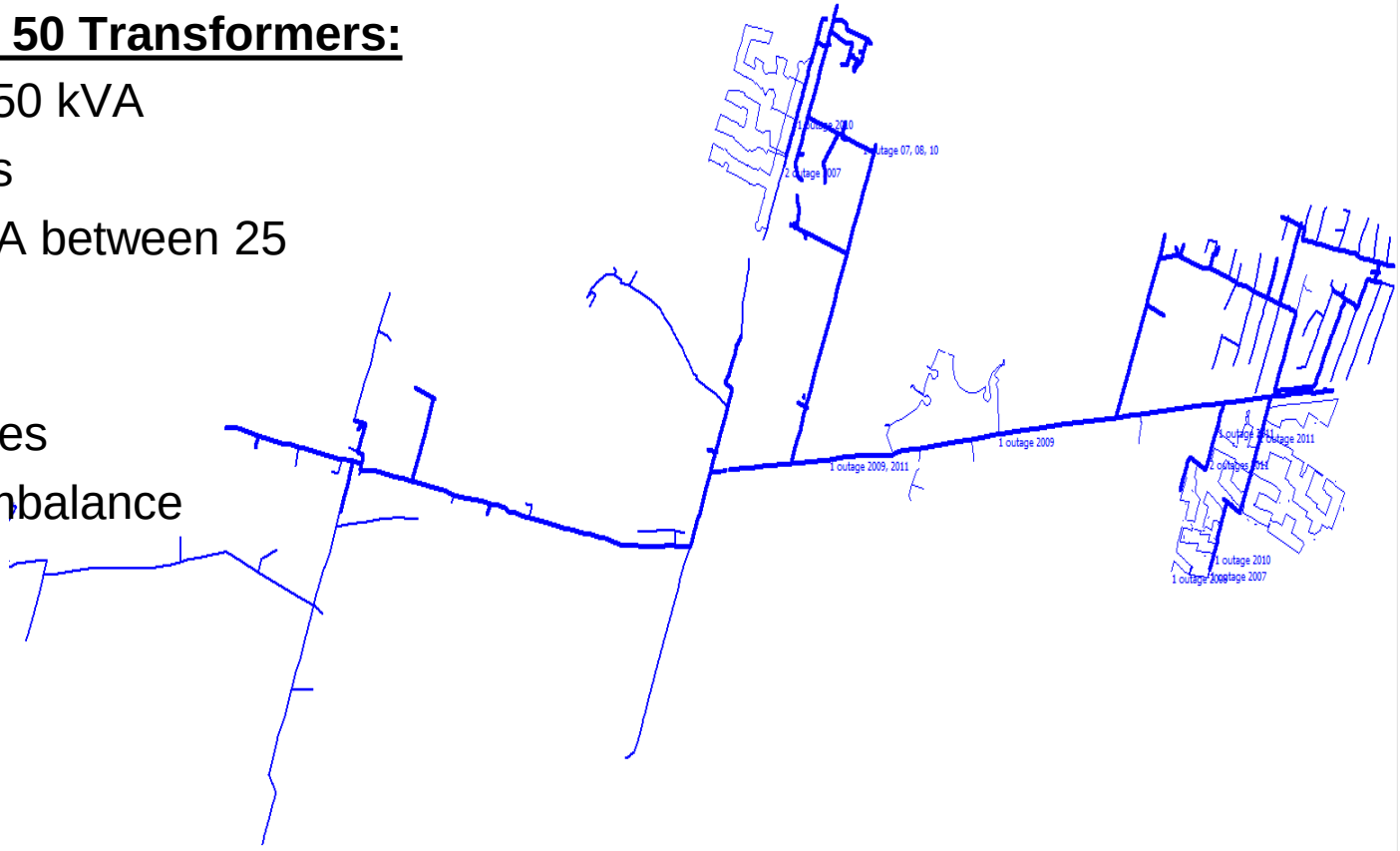
DEW CES Control Module I/O



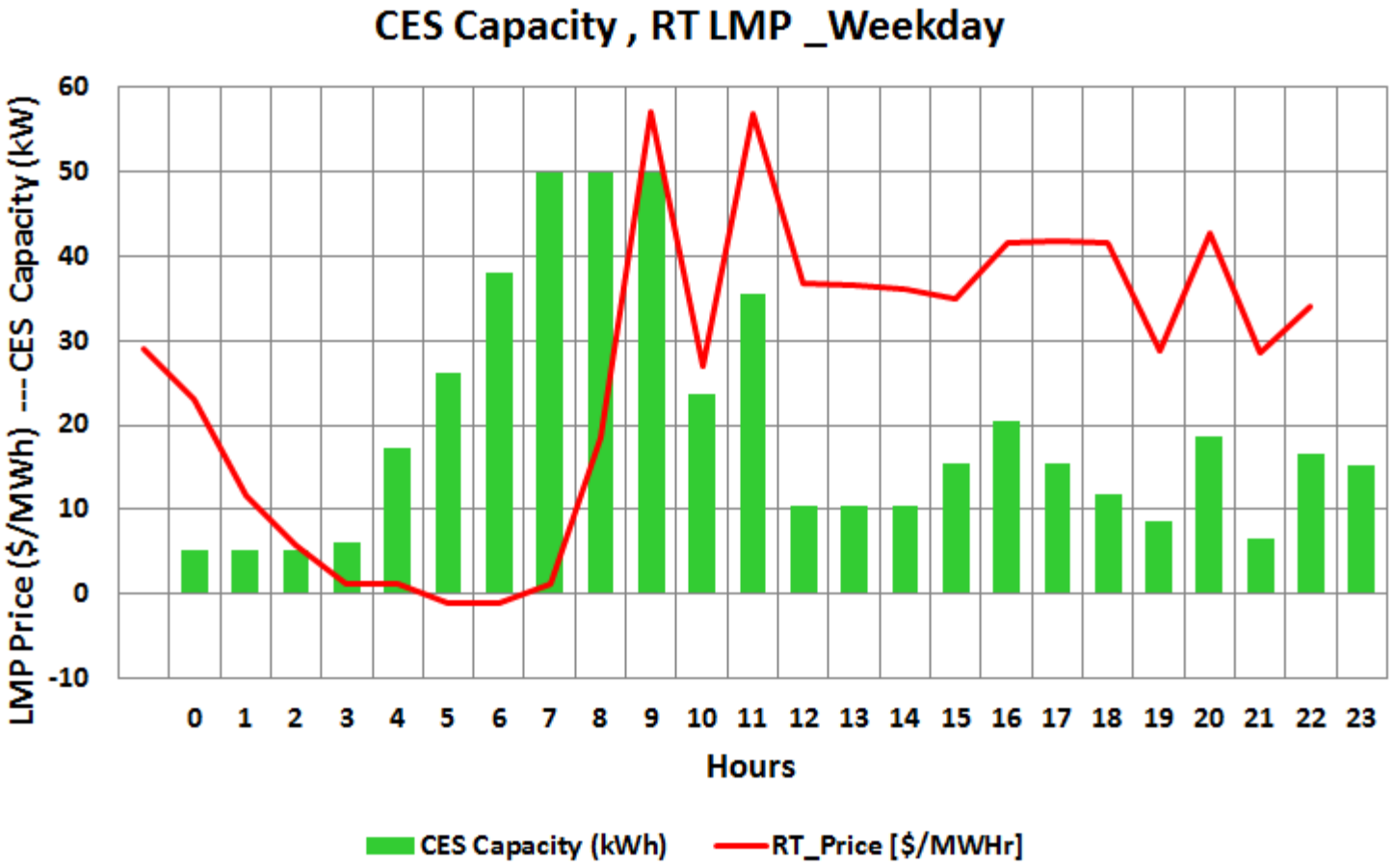
Distribution Circuit in DEW

Criteria for List of 50 Transformers:

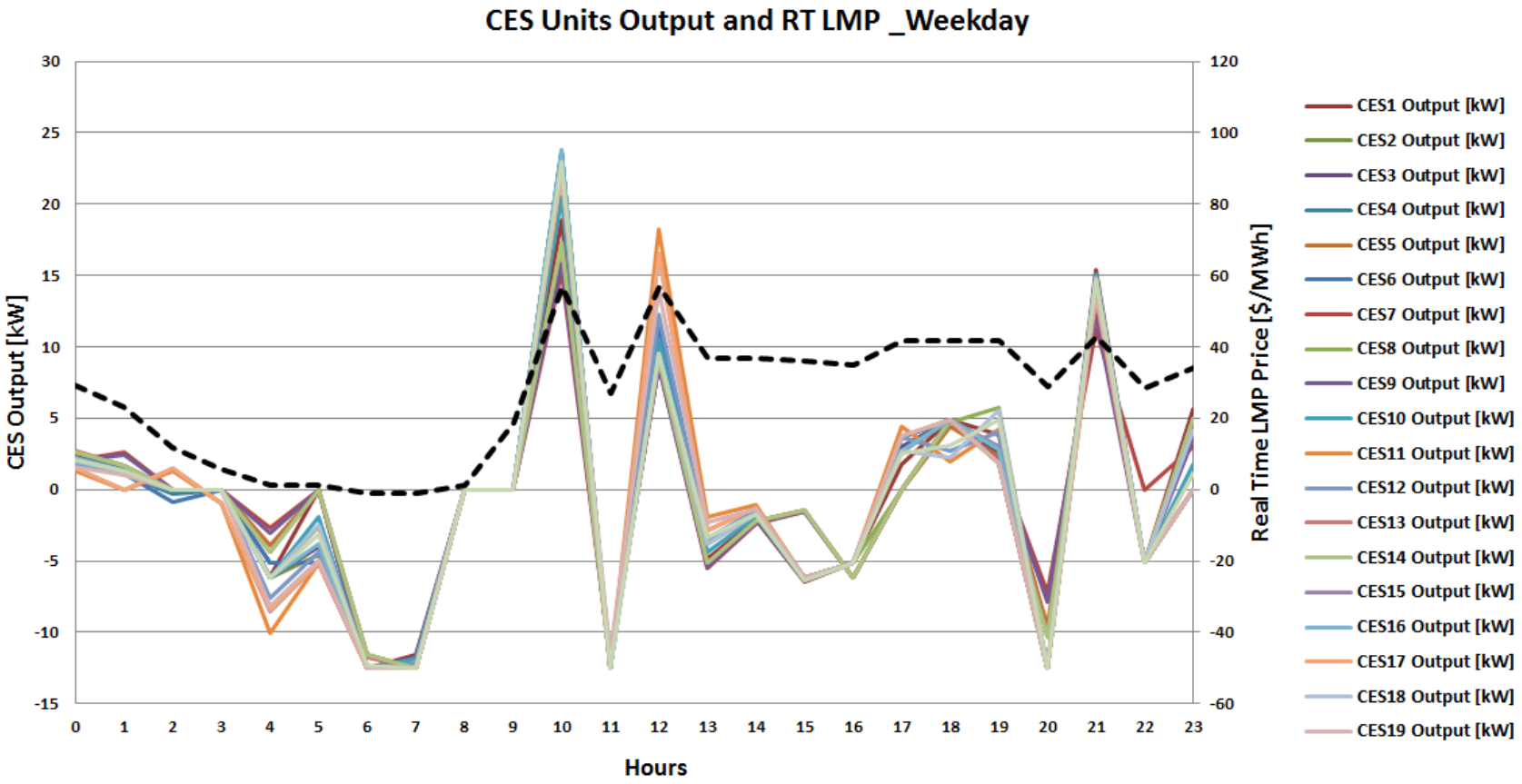
- Rated at 25 or 50 kVA
- 5-10 Customers
- Max Annual kVA between 25 and 50
- Heavily loaded
- Frequent outages
- Circuit phase imbalance
- Accessibility



Simulation Results, One CES Unit



Simulation Results, 20 CES Units



CES Test Plan

Testing	Test Description
Equipment/ Factory Acceptance Test	• S&C will design perform a factory acceptance test for the CES equipment • KEMA will provide an independent evaluation of initial design CES equipment.
Functional Test	• KEMA will develop a test plan and witness testing that will demonstrate the CES Unit capability to provide specific fundamental functions: i. Peak shaving, volt-VAR, demand response (ii. Remote communication and control of CES unit (DR SOC emulation) iii. Islanding iv. Respond to AGC simulated signal
System Test (DTE Field)	• The system test and evaluation will be performed in the field as the units are installed.
Testing of Automotive Batteries for Secondary Use Application	• KEMA's KERMIT model will be used for a portion of this analysis, establishing a model that projects remaining lifetime based on vehicle usage profile)
Comparative Test	• CES Unit original design test results will be compared to testing done on an identical CES Unit removed from service.

Secondary Use of EV Batteries

Battery Conditioning &Vehicle Durability Testing

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- **Project Activity**
  - Vehicle durability testing/battery conditioning started in June of 2011
  - Additional vehicles assigned to this program will begin durability testing later this month

- **Testing Locations for Mileage Accumulation & Battery Conditioning**
  - Chelsea Proving Grounds – Chelsea, MI
  - Arizona Proving Grounds – Yucca, AZ
  - Undisclosed Public Roads throughout North America

Secondary Use of EV Batteries

Battery Conditioning &Vehicle Durability Testing

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Beginning of Vehicle Reliability Testing

- Capacity – Verification Test
- Power pulse capability

Quarterly

- Cumulative vehicle miles
- Number of charge cycles
- Energy per charge and charge time
- Summary of battery issues related to DOE program

End of Automotive Useable Life – or End Vehicle Reliability Test

- Capacity – Total Available Energy
- 10 sec power pulse capability
- Total Charge / Discharge cycles
- Cumulative vehicle miles

Future Work

- Finalize functional test plan
- Test DR-SOC communication and controls with CES unit with S&C CES control unit
- Test and validate DEW reliability and economic dispatch algorithm
- Finalize physical design of CES unit
- Begin internal CES equipment review and approval process
- Begin working with communities on site approval process